

# **Ocean Dynamics/Doppler Sonar Observations Of Internal Solitary Waves in ASIAEX 2001**

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## **LONG-TERM GOALS**

To gain a more complete understanding of ocean dynamical processes, particularly at fine-scale, through intercomparison of high, mid- and low-latitude observations, both near the sea surface, in the main thermocline, and near the sea floor.

## **OBJECTIVES**

To identify the phenomena involved in the cascade of energy from mesoscales to turbulent scales. To quantify the relationship between fine-scale background conditions and the occurrence of microscale breaking.

## **APPROACH**

Progress is effected through a steady-state cycle of instrument development, field observation and data analysis. The primary instruments employed include Doppler sonar and profiling CTD's. Generically, our instruments produce information which is quasi-continuous in space and time. Measurements typically span two decades in the wavenumber domain. This broad band space-time coverage enables the investigation of multi-scale interactions.

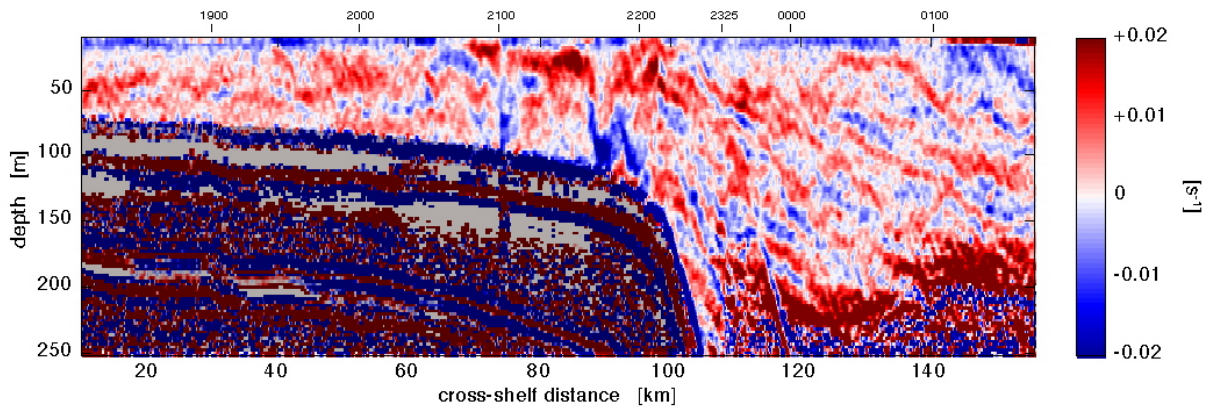
## **WORK COMPLETED**

We have participated in the first phase of ASIAEX (April-May 2000) in the East China Sea. Using the dual frequency Hydrographic Doppler Sonar System on the R.V. Roger Revelle, profiles of ocean currents were obtained to 700 m depth with 15 m vertical resolution and to 250 m with 3 m vertical resolution. In the course of the experiment, several transects of the Kuroshio were performed. The combined sonar and CTD data render a rather complete picture of the hydrographic fields.

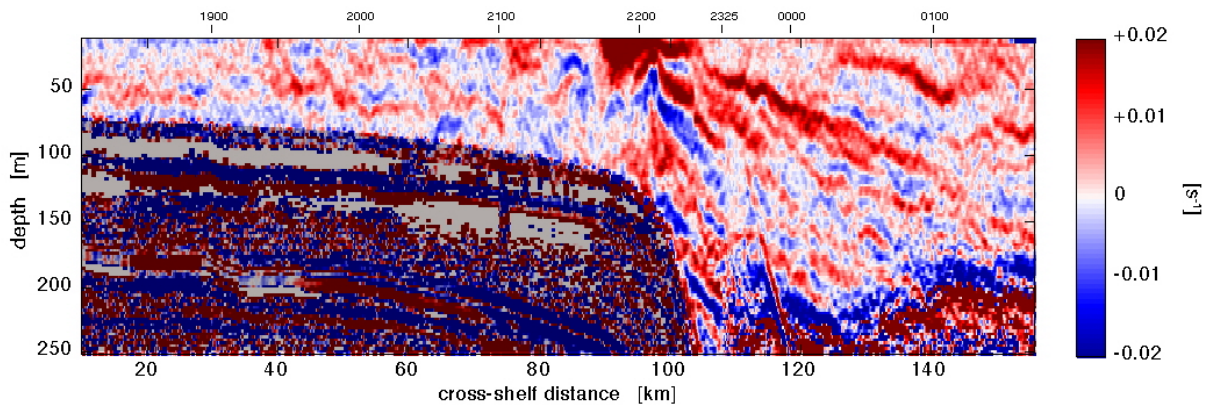
## **RESULTS**

Groups of very energetic internal waves were found (by graduate student Luc Rainville) to underlie the base of the Kuroshio. These are manifest as parallel sloping shear layers (downward offshore) which have horizontal coherence scales of 30-50 km. The observed slopes slightly exceed the slope of isopycnal surfaces, suggesting a near-inertial intrinsic frequency. The shear associated with these waves is very large compared to the geostrophic shear of the Kuroshio.

### Cross-shelf shear



### Along-shelf shear



*1. Maps of vertical shear measured by the High Resolution Sonar (140kHz) near the shelf break on April 17, 2000. For this line, the R/V Revelle was going from the continental shelf to deep water. Time (UTC) are marked on the upper axis of each panel. The bottom topography is indicated by the darker region. The along-shelf current (into the page) is dominated by the Kuroshio, with the front located at the shelf break, at a cross-shelf distance of about 95 km.*

### IMPACT/APPLICATIONS

We are in the process of determining whether these waves are actually drawing energy from the geostrophic field or are "merely" concentrated at the Kuroshio Front by the refractive effects of the geostrophic shear. In either event, these organized motions must greatly influence dissipative processes at the Front. In turn, they must be strongly influenced by the meandering nature of the Kuroshio and its interaction with the continental shelf.

The highly coherent, anisotropic, step-like features induced in the density field by the straining of these waves will have a profound influence on the propagation of sound, an influence of relevance to naval operations. Given the strong acoustic signature that these waves must have, an experiment focused on their study might well make use of acoustic techniques.

## **TRANSITIONS**

The information obtained in ASIAEX I is central to the planning of this year's ASIAEX II. The Hydrographic Doppler Sonar System on the R.V. Revelle (funded primarily by NSF and the University of California) will be kept in continuous operation for future users of the ship. It is suggested that other ships in the US research fleet might benefit from similar systems.

## **RELATED PROJECTS**

The shear data obtained in ASIAEX will be merged with the CTD data collected by Steve Ramp (NPGS) to produce a comprehensive picture of the region. Observations of wave phenomena at the shelf break and on the shelf will be applied to models of acoustic propagation in the region by Jim Lynch, Tim Duda, and John Colosi of Woods Hole.

## **PUBLICATIONS**

Alford, M.H., R. Pinkel, 2000: Observations of overturning in the thermocline: The context of ocean mixing. *J. Phys. Oceanogr.*, 30, 805-832

Alford, M.H., R. Pinkel, 2000: Patterns of Turbulent and Double-Diffusive Phenomena: Observations from a Rapid-Profiling Microconductivity Probe. *J. Phys. Oceanogr.*, 30, 833-854